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FOURTH SHUTTLE ORBITER FREE FLIGHT SET FOR OCT. 12

Orbiter Enterprise will undergo its first test in its space flight configuration at NASA's Dryden Flight Research Center, Edwards, Calif., when astronauts Joe Engle and Richard Truly bring the 75-ton spacecraft into a steep powerless landing closely resembling landings the Space Shuttle Orbiter will experience upon its return from space in 1979.

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(NASA-News-Release-77-216) FOURTH SHUTTLE
ORBITER FREE FLIGHT SET FOR OCTOBER 12
(National Aeronautics and Space
Administration) 10 p

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Engle and Truly, who piloted Enterprise on the second Free Flight test Sept. 13, will be at controls during this the shortest and steepest flight in the Approach and Landing Test Program. Flight time from separation to touchdown on the dry lakebed runway (Number 17) at the Edwards Air Force Base is slightly more than 2 minutes 30 seconds.

Enterprise which has been piloted to three successful free flights will be without its tailcone which provided smooth airflow and reduced drag of the 747/Orbiter combination. The 2,608-kilogram (5,750-pound) tailcone has been removed and has been replaced by three simulated engines. This configuration represents how the Orbiter will return from space.

The three Shuttle main engines are only used at launch to orbit in tandem with two solid rocket boosters which furnish liftoff power for the Shuttle. These engines are not used during reentry or during landing.

Without the tailcone it is estimated the 747 will receive about three times the amount of buffeting. This buffeting is expected to reduce by 50 per cent the stability of the 747 carrier aircraft and also reduce the rudder control of the 747 by nearly 20 per cent.

In previous free flights, with tailcone on the 747 has been able to attain release altitude of more than 7,000 meters (23,000 feet) and launch separation speed of 270 knots in about 45 minutes. Without the tailcone, release altitude will be about 5,500 m (18,000 ft.) and at an airspeed of 245 knots.

Discrete checks will be made by onboard crew members and by ground controllers throughout the climb to altitude to assure that the 747/Orbiter can reach proper altitude without excessive buffeting which might interfere with a nominal separation of the two craft. A practice separation will be conducted at 5,500 m (18,000 ft.) above ground level (AGL), after which the 747 with its engines pushed to special rated thrust will climb back to 7,700 m (22,000 ft.) AGL for pushover and release of the Orbiter.

Enterprise will descend to the Edwards dry lake runway at about a 22-degree angle, much like a dive bomber attack. Approach angle on the three previous flights has been about 11 degrees. Release of Enterprise occurs when the vehicles are several miles north of California Highway 58, north of Edwards.

During climb to altitude the 747/Orbiter follows along a racetrack pattern which is 135.2 km (73 nautical mi.) in length.

The flight is as follows:

- After takeoff various buffet, flutter, load stabilization control checks are made as the mated configuration climbs to altitude. Approximately 25 minutes after takeoff the 747 noses over to perform a "dress rehearsal" for a separation at about 5,500 m (18,000 ft.) AGL. This practice separation run is concluded at about 4,400 m (14,500 ft.) AGL when another series of flight control checks are conducted aboard the Orbiter.

- The crew of the 747 then applies special rated thrust to the modified engines for the climb from 5,600 m (18,500 ft.) AGL to the separation altitude. Pushover of the 747 will occur at about 56 minutes after takeoff at 6,700 m (22,000 ft.) AGL.

- Separation occurs about one minute after pushover when the 747/Orbiter reaches an altitude of about 5,500 m (18,200 ft.) AGL. The Orbiter is now about 33 km (20 mi.) from touchdown.

- Sixteen seconds after separation the Enterprise crew initiates aerodynamic stick inputs (ASI) to the Orbiter to determine control surface and aerodynamic responses of the vehicle.

- A slight left turn, the first of two turns, is commanded by the crew 30 seconds after release, followed by a pushover of the Orbiter at 39 seconds. Five seconds later when the Enterprise is at 4,700 m (15,500 ft.) AGL controls are commanded to pull the Orbiter nose back up to slow its descent. Another pushover and pullup follow to an altitude of about 3,800 m (12,500 ft.) AGL where another series of aerodynamic stick inputs (ASI) are reinitiated to test the control surfaces and handling capabilities of the Orbiter after one minute and 10 seconds of free flight.

- At 2,500 m (8,200 ft.) AGL and when Enterprise is descending at a speed of about 537 km/hr (299 knots) the speed brakes are deployed to about 30 per cent which reduces the Enterprises's speed. A few seconds later at 1 minute 34 seconds after separation, the second left turn is performed, lining the vehicle up for its final approach to landing on Runway 17.

- Two minutes after separation and about 30 seconds and 580 m (1,900 ft.) AGL from landing, the Enterprise crew commands a preflare (pulling the nose up) which reduces airspeed for landing.

- Touchdown of Enterprise is about 2 minutes 34 seconds after separation from the 747 carrier airplane.

ALT FREE FLIGHT TIMELINE

| <u>Event</u> | <u>Altitude</u> | <u>T-Time</u> | <u>PDT a.m.</u> | <u>EDT</u> |
|--|-----------------|---------------|-----------------|------------|
| Crew Wakeup | | T-240 | 4:00 | 7:00 |
| Crew Depart Quarters | | T-210 | 4:30 | 7:30 |
| Crew Arrives Trailer (physical & breakfast) | | T-195 | 4:45 | 7:45 |
| Crew Departs for Suitup Trailer | | T-160 | 5:20 | 8:20 |
| Crew Departs Trailer | | T-125 | 5:55 | 8:55 |
| Start Ingress | | T-120 | 6:00 | 9:00 |
| Ingress Complete | | T-98 | 6:22 | 9:22 |
| ALT Ground Team/Flight Team Handover | | T-67 | 6:53 | 9:53 |
| Orbiter/SCA Move From MDD*** | | T-62 | 6:58 | 9:58 |
| Orbiter/SCA Tow to NASA Ramp | | T-56 | 7:04 | 10:04 |
| SCA Engine Start | | T-42 | 7:18 | 10:16 |
| SCA Begin Taxi | | T-32 | 7:28 | 10:28 |
| SCA Arrive Runway | | T-12 | 7:48 | 10:48 |
| Navigation Update | | T-4 | 7:56 | 10:56 |
| SCA Brake Release, Takeoff Climbout | | T-0 | 8:00 | 11:00 |
| MD/OSS LIU/Load Check | 3,000 | T+3 | 8:03 | 11:03 |
| SCA Buffett Check | 7,500 | T+8 | 8:08 | 11:08 |
| Separation Data Run | 18,500 | T+25 | 8:25 | 11:25 |
| FCS Data Run | 14,500 | T+29 | 8:29 | 11:29 |
| SRT | 18,500 | T+40 | 8:40 | 11:40 |
| Pushover | 22,000 | T+56 | 8:56 | 11:56 |
| <u>Separation Point</u> | | | | |
| Separation, pullup, | 18,200 | | | |
| Body Flap 34% | 17,700 | | 8:57 | 11:57 |
| Pushover | 17,850 | | 8:57:11 | 11:57:11 |
| First left turn, ASZ s | | | | |
| Pushover | 16,700 | | 8:57:32 | 11:57:32 |
| Pullup | 15,500 | | 8:57:44 | 11:57:44 |
| Pushover | 14,500 | | 8:57:55 | 11:57:55 |
| Pullup | 13,000 | | 8:58:08 | 11:58:08 |
| ASI's | 12,300 | | 8:58:12 | 11:58:12 |
| Second Left Turn, | | | | |
| Speedbrake 30% | 7,300 | | 8:58:36 | 11:58:36 |
| ASI's | 5,000 | | 8:58:48 | 11:58:48 |
| Speedbrake Closed, | | | | |
| Initiate Preflare | 1,900 | | 8:59:05 | 11:59:05 |
| Deploy Landing Gear | 200 | | 8:59:23 | 11:59:23 |
| T.D. | 0 | | 8:59:35 | 11:59:35 |
| Mod-hard Differential Brake | | | 8:59:45 | 11:59:45 |
| Gentle-mod Brake | | | 8:59:50 | 11:59:50 |
| Orbiter Stop | | | 9:00:00 | 12:00:00 |

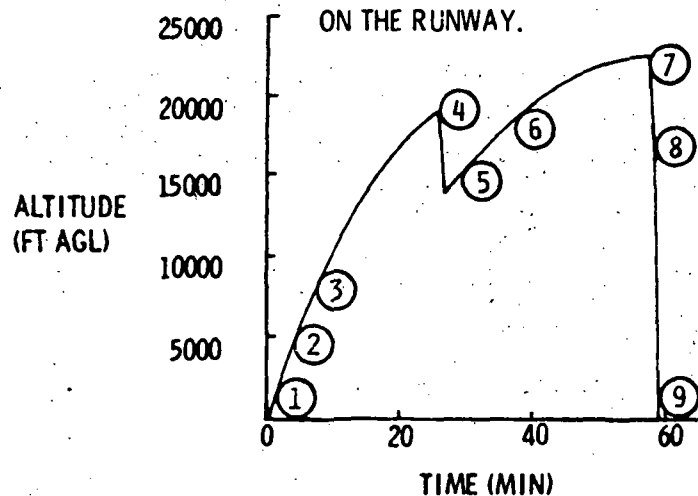
MATED PROFILE FREE FLIGHT 4

FLIGHT SEQUENCE

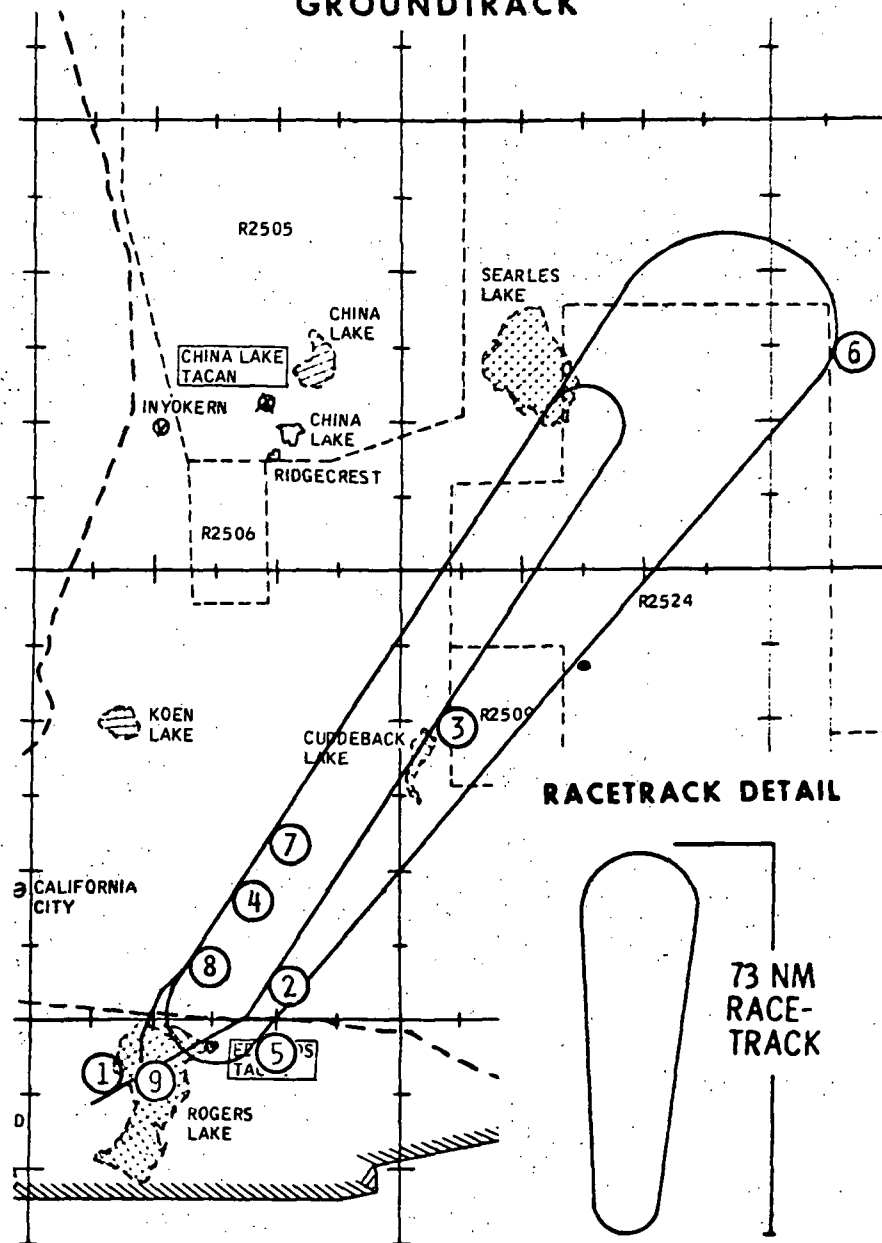
| ITEM | TIME | ALT (AGL) | RG (NM) | EVENT |
|------|------|-----------|---------|---------------------|
| ① | 0 | 0 | 0 | SCA TAKE OFF |
| ② | 3 | 3 000 | 11 | MD/CSS LIM/LOAD CHK |
| ③ | 8 | 7 500 | 35 | SCA BUFFET CHK |
| ④ | 25 | 18 000 | 27 | SEP DATA RUN |
| ⑤ | 29 | 14 500 | 14 | FCS CHKS |
| ⑥ | 40 | 18 500 | 64 | SRT |
| ⑦ | 56 | 22 000 | 30 | PUSHOVER |
| ⑧ | 57 | 18 200 | 20 | SEP |
| ⑨ | 59 | 0 | 0 | ORBITER LANDING |

ALTITUDE PROFILE

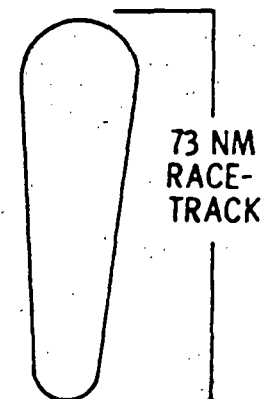
NOTE: ALTITUDES ARE ABOVE GROUND LEVEL (AGL) AND ARE REFERENCED TO ORBITER GROUND AIM POINT ON THE RUNWAY.



GROUNDTRACK



RACETRACK DETAIL

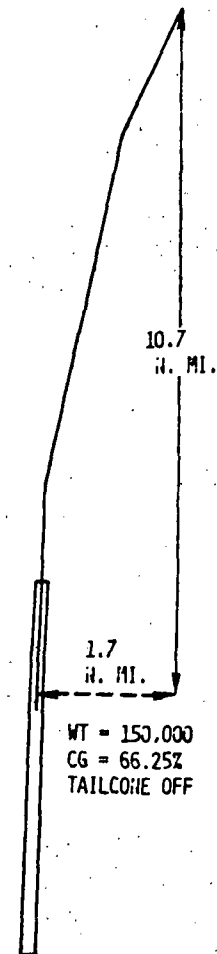
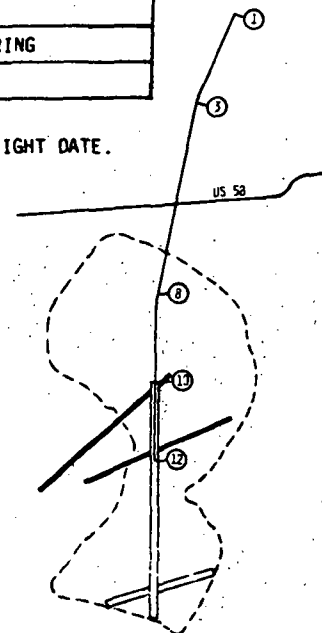
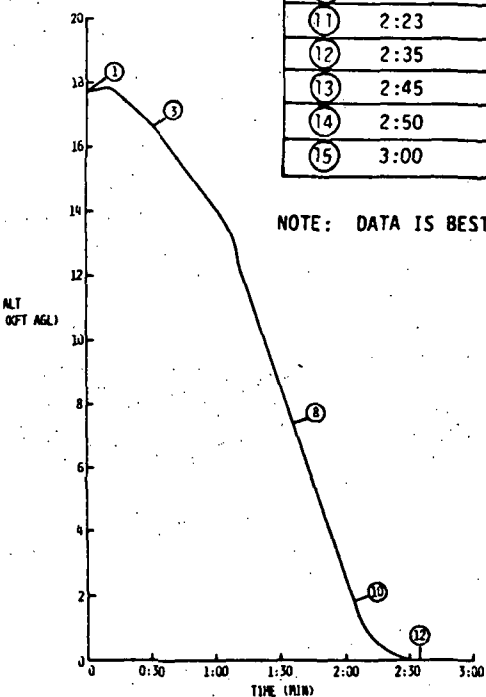


DATE 09/30/77

ALT FREE FLIGHT 4

| ITEM | TIME | ALT(AGL) | KEAS | α | θ | ACTION |
|------|------|----------|------|----------|----------|--|
| ① | 0:00 | 17 700 | 245 | 10 | .5 | SEP; $\dot{\theta} = 2$ DEG/SEC TO $\theta = 15$ DEG; $\psi = 195$ DEG; BF = 34% |
| ② | 0:11 | 17 850 | 197 | .8 | -15 | $\dot{\theta} = -3$ DEG/SEC TO $\theta = -1.5$ DEG, AERO STICK INPUTS |
| ③ | 0:32 | 16 700 | 185 | 9 | -1.5 | ROLL LEFT TO $\psi = 185$ DEG; $\dot{\theta} = -2$ DEG/SEC TO $\theta = -12$ DEG |
| ④ | 0:44 | 15 500 | 192 | 6 | -12 | $\dot{\theta} = 2$ DEG/SEC TO $\theta = 10$ DEG |
| ⑤ | 0:55 | 14 500 | 186 | 13 | 10 | $\dot{\theta} = -2$ DEG/SEC TO $\theta = -25$ DEG |
| ⑥ | 1:08 | 13 000 | 220 | 3 | -25 | $\dot{\theta} = 2$ DEG/SEC TO $\theta = -16$ DEG |
| ⑦ | 1:12 | 12 300 | 230 | 9 | -16 | AERO STICK INPUTS |
| ⑧ | 1:36 | 7 300 | 290 | 6 | -16 | SPD BRK TO 30%; ROLL LEFT TO $\psi = 175$ DEG |
| ⑨ | 1:48 | 5 000 | 290 | 4 | -16 | AERO STICK INPUTS |
| ⑩ | 2:05 | 1 900 | 290 | 4 | -16 | SPD BRK CLOSE; PREFLARE |
| ⑪ | 2:23 | 200 | 250 | 6 | 0 | DEPLOY GEAR |
| ⑫ | 2:35 | 0 | 185 | 8 | 8 | TOUCHDOWN |
| ⑬ | 2:45 | 0 | 130 | -- | -- | MODERATE TO HARD DIFFERENTIAL BRAKING |
| ⑭ | 2:50 | 0 | 100 | -- | -- | GENTLE TO MODERATE BRAKING, NOSEWHEEL STEERING |
| ⑮ | 3:00 | 0 | 0 | -- | -- | ORBITER STOP |

NOTE: DATA IS BEST ESTIMATE AS OF 9/28/77 AND IS SUBJECT TO MINOR VARIATION ON OR NEAR FLIGHT DATE.



WT = 150,000
CG = 66.25%
TAILCONE OFF

DATE 09/30/77

ACTUAL TIMES/ALTITUDES TIMELINE

-10-

Free Flight 1 (Haise & Fullerton)
August 12, 1977

| <u>Event</u> | <u>PDT</u> | <u>Altitude, AGL</u> | <u>Speed, knots</u> |
|------------------------------------|------------|----------------------|---------------------|
| SCA/Orbiter brake release, takeoff | 8:00:00 | | |
| Intersect racetrack | 8:15:30 | 19,500 | |
| Flight control systems check | 8:22:14 | 22,500 | |
| Begin special-rated thrust | 8:36:43 | 26,200 | |
| Pushover for Orbiter separation | 8:47:40 | 28,000 | |
| Orbiter separation | 8:48:29 | 24,000 | 270 |
| Orbiter landing | 8:53:51 | 0 | 185 |

Total Orbiter Free Flight time: 5 min 22 sec

Average rate of sink: 4615 fpm

Touchdown was about .75 mile beyond predicted TD point

Touchdown-to-stop rollout approximately 11,000 feet

Free Flight 2 (Engle & Truly)
September 13, 1977

| <u>Event</u> | <u>PDT</u> | <u>Altitude, AGL</u> | <u>Speed, knots</u> |
|--------------|------------|----------------------|---------------------|
| Takeoff | 8:00:00 | | |
| Pushover | 8:48:34 | 28,300 | |
| Separation | 8:49:24 | 24,000 | |
| Main Gear | 8:54:55 | | |
| Nose Gear | 8:55:10 | | |
| Stop | 8:56:10 | | |

Highest Speed: 300 knots

Lowest Speed: 185 knots

Touchdown: 194 knots

Free Flight Total: 5 min 31 sec

Touchdown 680 ft. past aim point

Free Flight 3 (Haise & Fullerton)
September 23, 1977

| <u>Event</u> | <u>PDT</u> | <u>Altitude, AGL</u> | <u>Speed, knots</u> |
|------------------|------------|----------------------|---------------------|
| Takeoff | 8:00:47 | | |
| Pushover | 8:44:58 | 26,700 | |
| Separation | 8:45:37 | 21,400 | 250 (287 mph) |
| Touchdown (main) | 8:51:12 | | 191 (219 mph) |
| Nosegear | 8:51:23 | | |
| Rollout | | 9,147 | |

Touchdown 786 ft. beyond aim point

Autoland System: .45 seconds

Total Free Flight: 5 min 34 sec

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